Astrodynamics/Introduction

Astrodynamics

Introduction to Astrodynamics

Astrodynamics is the study of the interaction and motions of objects in space. While there are many generalized ways of studying astrodynamics, it makes the most practical sense to study the earth and the actions of objects in orbit around the earth. Similarly, it is more practical to study the gravitational effects of our sun than it is to study the gravity of any arbitrary star. This book will provide the basic mathematical foundation for the study of astrodynamics but will take specific care to focus on man-made craft launched from the earth, intended to orbit the earth.

What Will This Book Cover?

This book will cover the necessary concepts and mathematics to study orbital motion. This book will focus on theory, although with a strong focus on practical applications of that theory. This book will focus on the earth and spacial objects that interact with earth including the sun, the moon, comets, asteroids, man-made orbital satellites, and ballistic missiles.

This book will not cover astronomy or astrophysics in a general sense.

Who Is This Book For?

This book is for engineers and physicists alike. It will be directed towards undergraduate students in a science or engineering program, who have had at least 1 semester of physics and two or three semesters of calculus.

What Are The Prerequisites?

Readers of this book should be familiar with vector calculus and multi-variable calculus. Readers should know and understand calculus-based physics of motion. This book will not discuss vectors, vector arithmetic, vector calculus, multi-variable calculus, or basic physics. For those topics, you should consult the following books:

- Calculus
- Modern Physics
- Engineering Analysis

Readers who are unfamiliar with vector calculus will be at an extreme disadvantage when reading this book, and are encouraged to read the necessary passages of Calculus first. Because of the frequent use of conic sections, the student may also wish to read Conic Sections as well.

Mathematical Notation

This book will use a simplified notation to express equations.

- Complicated mathematical formulae that need to be rendered with LaTeX will be moved to a new line, and indented. Important equations like this will be labeled on the right. Rendered equations should never be in-line with text in a paragraph, because the spacing is different.
- Scalar values or scalar-valued functions will be written in lower-case italics, such as *i*. Because nearly everything in astrodynamics is a function of time, we will leave off the argument *(t)* from our functions. I.e. we will write the distance of a satellite from earth as *r* even though it's the function of time *r(t)*.
- Greek or other non-Latin characters will not be made italic, because they are difficult to see in the body of text.
- Vectors and vector-valued functions will be written in bold. For example, **r** is a position vector. If the vector changes with time, the *(t)* will be implied. If we use a scalar and a vector with the same letter in the same place, such as *r* and **r**, we know that the scalar value is the euclidean distance of the vector:

$$r = |\mathbf{r}|$$

- Time derivatives of functions will be expressed in dot notation:

$$\dot{\mathbf{r}} = \frac{d\mathbf{r}}{dt}$$
$$\dot{r} = \frac{d}{dt}|\mathbf{r}| \neq \left|\frac{d\mathbf{r}}{dt}\right|$$

Wikipedia

Astrodynamics is a large topic, and there is no way to discuss all information of peripheral interest. This book will link extensively to related articles in **Wikipedia**. Links to Wikipedia articles represent departure points for additional reading and are not required for the understanding of the material in this book. Also, articles in Wikipedia are written with different styles, and frequently with different terms and mathematical notation as is used in this book. This book uses a consistent vocabulary and mathematical notation, and no attempt will be made to synchronize this book with any Wikipedia articles.